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(54) Abstract Title
Stencil with mounting apertures and stress relief region

(57) A stencil 100 comprising mounting apertures 106, 108 with linear side edges, the apertures 106, 108 being wider at the end facing toward the centre of the stencil than at the end facing the edge of the stencil, i.e. tapered (shown in enlarged form at 112); and stress relief means 114, 116 formed by a pattern of openings 130 and disposed in a region located inboard of the mounting apertures 106, 108; where the average spacing of the stress relief openings to the mounting apertures is a ration in the range of from .075/1 to 5/1. The dimensions of mounting holes 106, 108 assist in aligning and tensioning the stencil 100 within a mounting frame. The stencil also has a separation band 150, although this is not essential (see figure 5). The stencil may have stress relief end enlargement regions 120, 122 which extend beyond mounting apertures 106, 108 and up to cut off corner region 124.

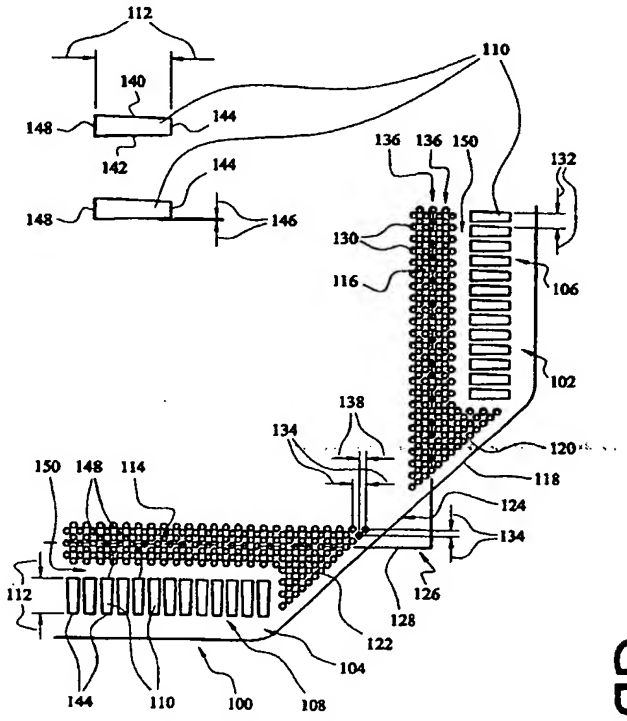

FIG. 4

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

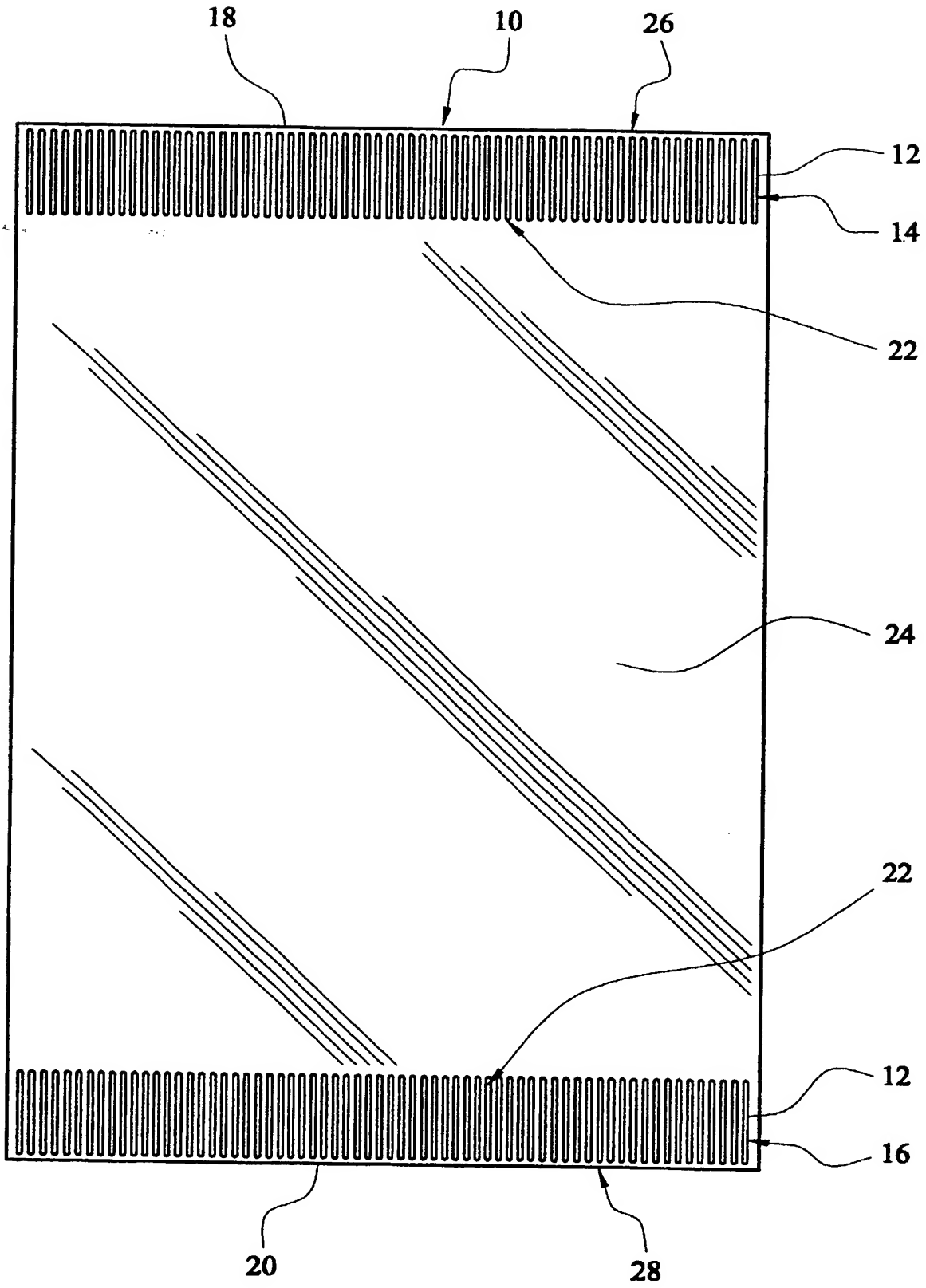

FIG. 1

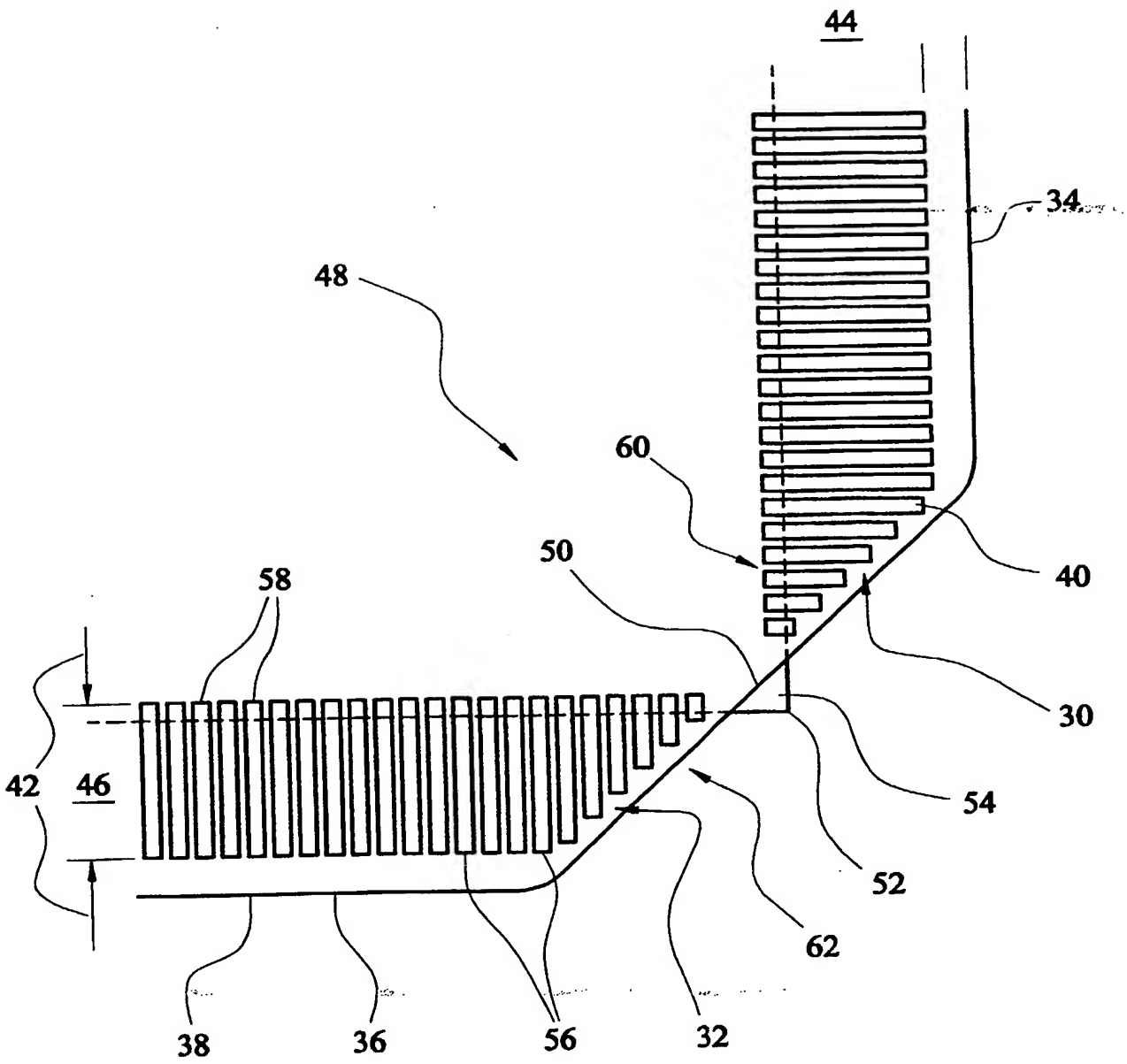

FIG. 2

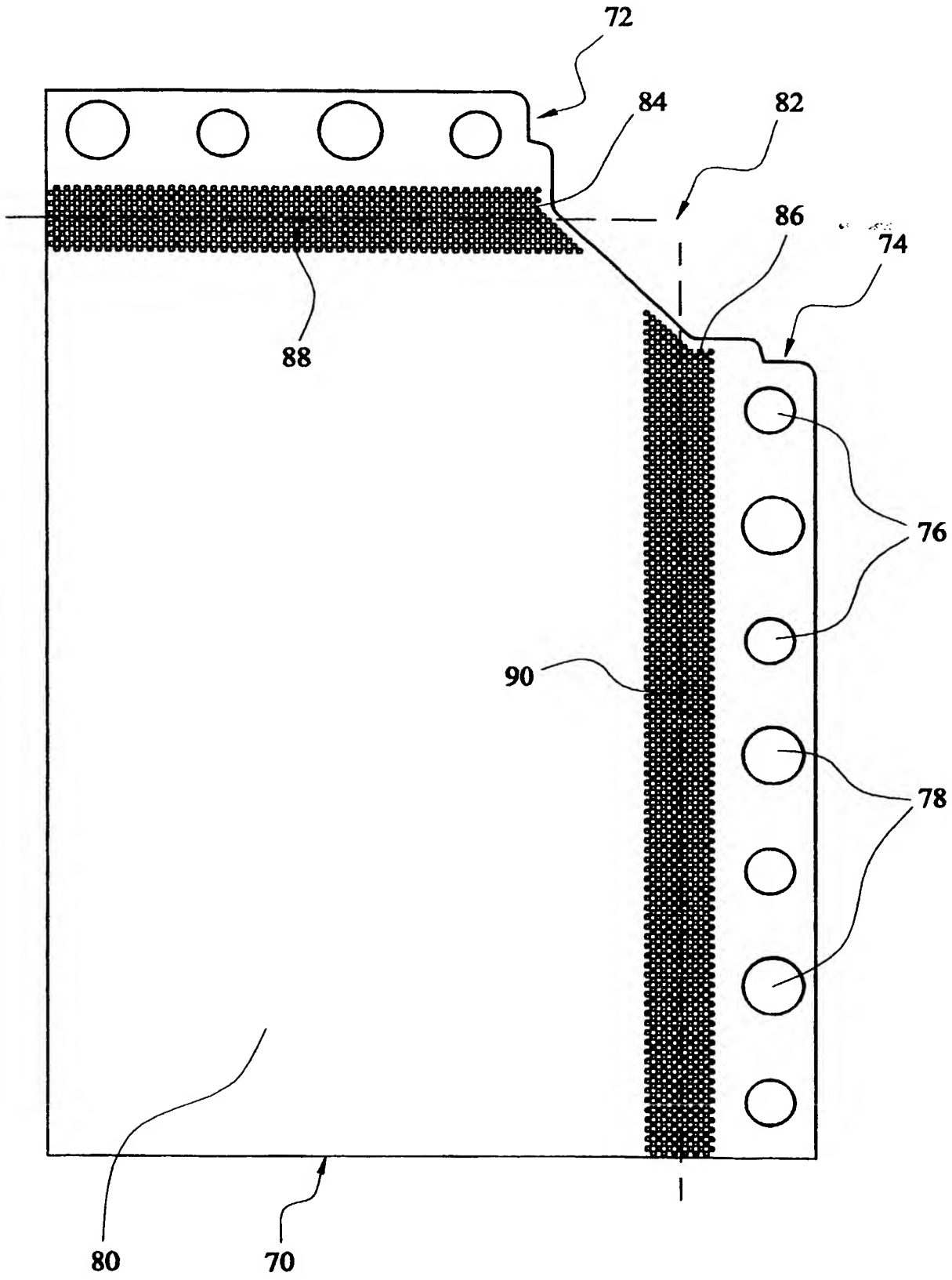

FIG. 3

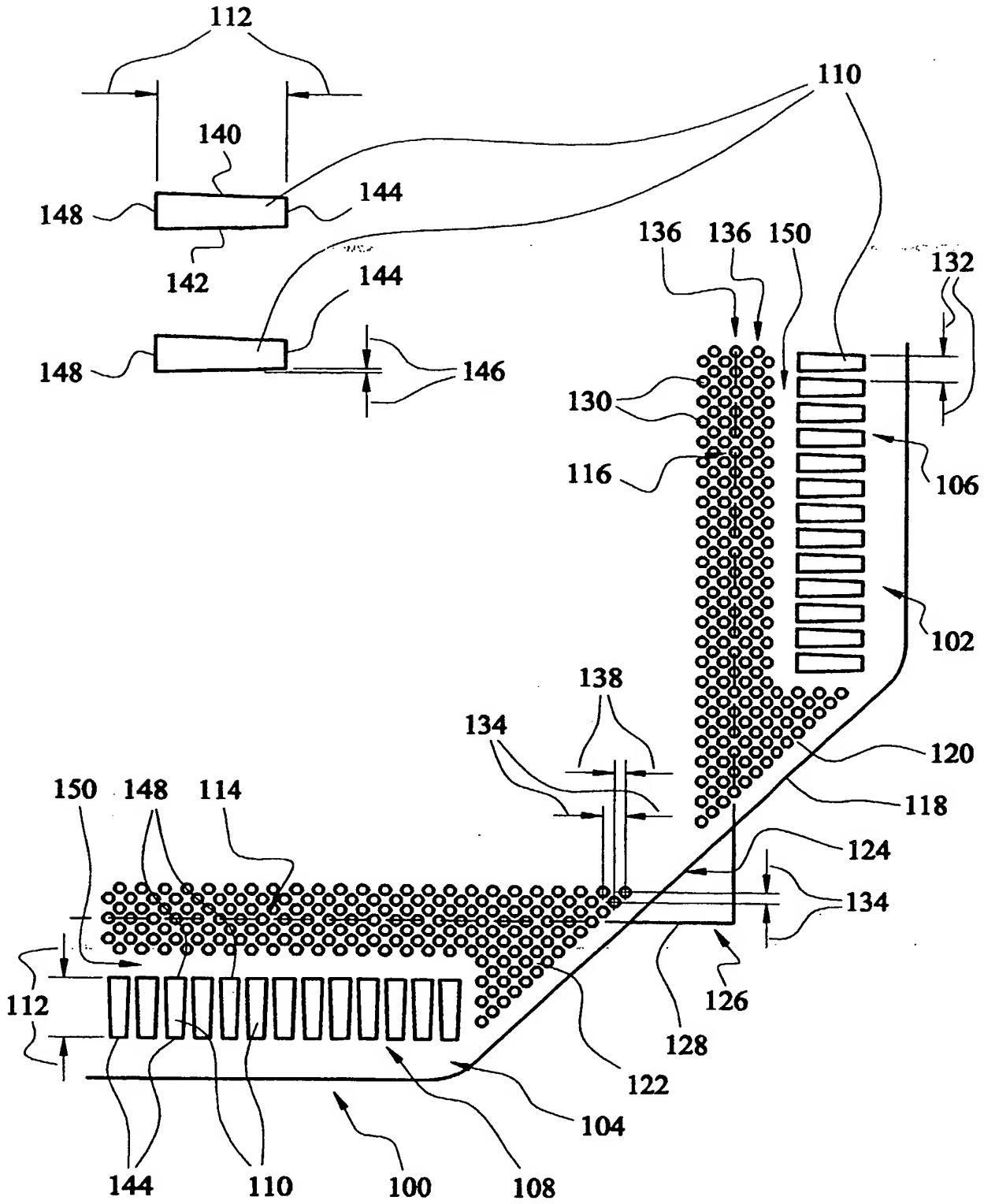

FIG. 4

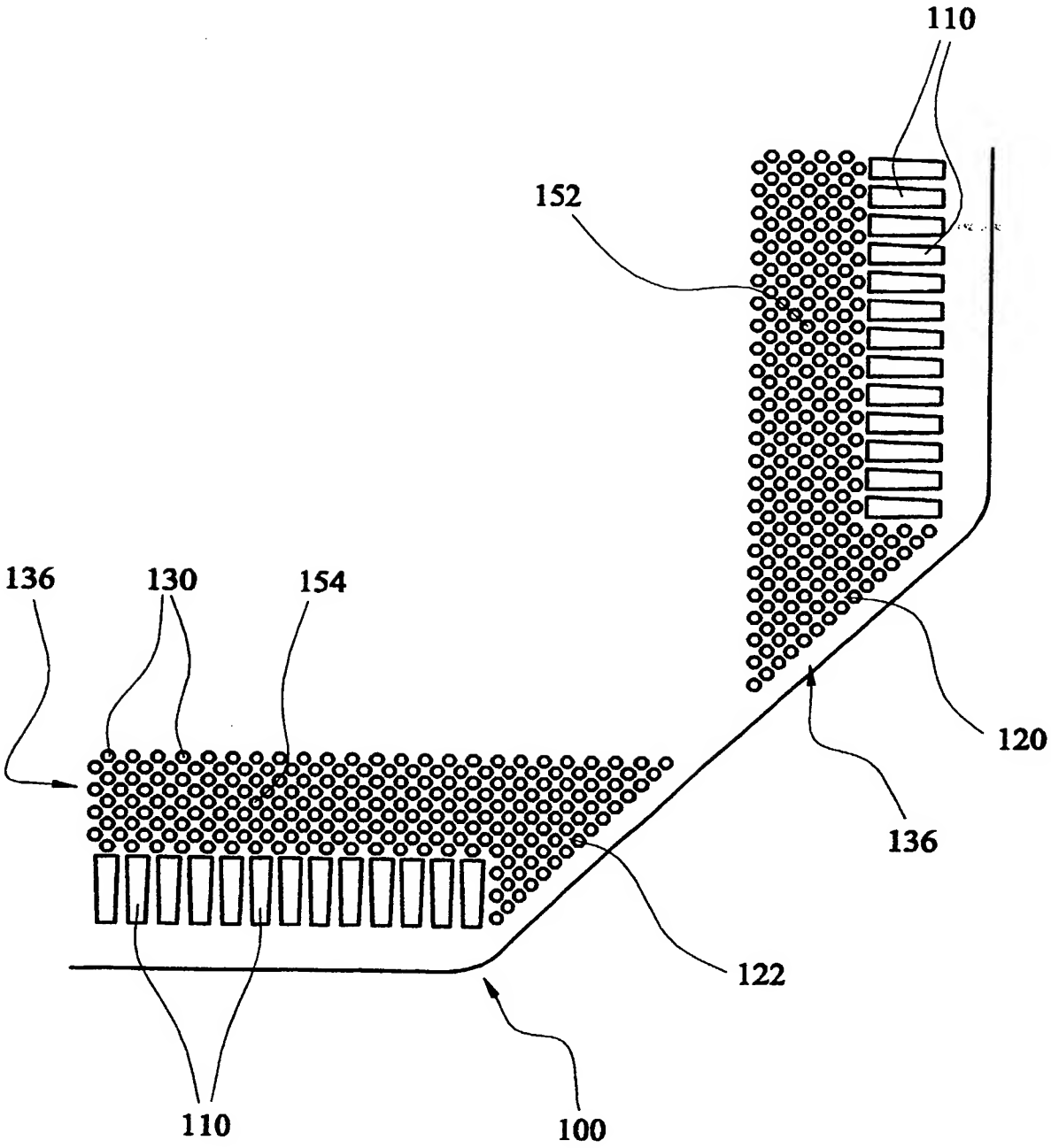

FIG. 5

STENCIL FOR USE WITH STENCIL MOUNTING FRAME

This invention relates to a stencil for use with a stencil mounting frame. An example of a stencil and a mounting frame of the general kind with which the present invention is concerned is disclosed in GB 2264460 B and in the corresponding European patent specification EP 0643902 B. Such stencils and mounting frames are used, for example, in relation to the manufacture of printed circuit boards using a squeegee or other suitable technique for the application of solder paste in a printing-like manner to the board structure using an etched pattern of openings or apertures formed in the stencil. From this is will be readily appreciated that it is important that the stencil is, during the squeegeeing operation held as totally flat as possible in order that the squeegeeing action does not produce a "ripple" effect across the stencil as the squeegee action progresses.

With this problem in mind the text of the GB 2264460 B specification mentioned above and likewise the EP 0643902 B specification propose that opposite side regions of the stencil should be apertured or of reduced thickness so as to be more flexible than the main body of the sheet of the stencil so as to enable the opposite side regions to be bent along these regions without kinking or other deformation during tensioning. For this purpose, the system of the GB 2264460 B specification and the EP 0643902 B specification propose that the interconnection means for connecting the stencil to its frame should be provided by means of a plurality of parallel slots extending from each edge of the stencil towards the other edge by an amount sufficient to make the edge sufficiently flexible for the purpose and likewise sufficiently closely spaced so as to avoid or minimise any distortion in the main body of the sheet upon tensioning. The closely spaced slots on opposite

edges are preferably aligned to avoid or minimise distortion. In the embodiments of the above-mentioned GB and EP specifications, the inter-engaging means comprise comb-like members 10 cooperating with corresponding elongated slots 6,7 and the slots extend over a sufficient length so as to make the edges of the stencil more flexible than the main body portion.

We have established however that the adoption of this construction utilising relatively long slots to cooperate with the comb-like mounting or tensioning members in turn leads to significant technical problems. For example, the long slots lead to weakness in the material of the stencil throughout this portion of substantial width and this in turn leads to difficulties in the precision cooperation or meshing of the stencil with the comb during the mounting process. Moreover, the slots themselves are not well adapted to the provision of the necessary additional flexibility as proposed in the GB 2264460 B and EP 0643902 B specifications. Thus, there are problems in terms of the ease of fitting of the stencils to the stencil frame, and the degree of precision with which the stencil, when mounted, is caused to adopt a generally flat configuration.

We have established that there is a basis for adopting a completely different approach to the stencil mounting and stencil stress-relief functions which are potentially of very significant benefit to the user. Thus, for example, we have established that a format can be adopted for stencils which enables these to cooperate satisfactorily with existing stencil-mounting frames made in accordance with the above EP 0643902 B and GB 2264460 B specifications, but in which the flexibility and stencil tensioning functions are based upon a completely different philosophy.

Thus, in accordance with this modified approach, we provide, firstly, entirely separate, physically separate in terms of their actually location on the stencil, features

which serve to provide the stencil mounting and stencil stress relief functions. Indeed, we see the function of stress relief as more significant than "stencil flexibility" as expressed in the above GB 2264460 B and EP 0643902 B specifications and in this connection we provide in the embodiments of this invention a stress-relief function constructed and arranged in accordance with the teaching in our own GB 2286155 B specification and the corresponding EP 0662878 B specification.

In accordance with our modified approach, the stencil mounting and stencil stress relief functions are entirely separated and for the purpose of the mounting function, there are simply provided mounting apertures at the required spacings but which themselves are not remotely of a length comparable to that disclosed in the above EP 902 B and GB 460 B specifications, and thus, are not significantly elongated at all, but have a profile well adapted to facilitate ready mounting on the stencil frames. For this latter purpose we provide a portion of each aperture which is wider than another portion thereof so that the comb-like projections or inter-engaging means can readily enter into the slightly wider portions of the holes in the stencil and can then move a very short distance to the other narrower portion of the stencil so as to cooperate effectively therewith in defining the position of the stencil.

Thus, this feature facilitates the mounting of the stencils on the stencil frame by eliminating the generally weak construction deliberately adopted (in the EP 902 B and GB 460 B specifications) in a substantial peripheral edge region of the stencil, whereby the latter is significantly stronger than has hitherto been adopted and this in itself leads to significant advantages in terms of the mounting function inter-engagement step and the general robustness of the stencil in relation to this important function of

the stencil.

Then, in relation to the stress release of the stencil, we adopt as a physically separate construction, although that construction can and does overlap with the mounting function region, the use of stress relief apertures in accordance with the disclosure in our GB 155B and EP 878 B specifications.

Thus by adopting this "separate functions" design approach we achieve simpler and better results. So far as stencil stress relief is concerned, the arrangement disclosed in our EP 878 B and GB 155 B specifications is without doubt extremely effective in ensuring that the lines of action of the tension forces exerted on the stencil by the comb-mounting elements have to pass through a portion of the stencil which causes effective stress relief.

For mounting purposes, we provide the simple concept of mere mounting holes or apertures adapted to receive the comb-like inter engaging or mounting members. This approach is well established and our research shows that it produces a much more beneficial and technically advantageous effect, than is achieved by the long slot-like formations which the specifications of the EP 902B and GB 460 B patents require.

In this way, each inter-engaging comb-like member has its own hole. That hole is relatively small, being just large enough to receive its own comb tooth and thus corresponds in this respect to a conventional mounting hole to co-operate with the usual mounting peg.

By the separation of the functions of stencil stress relief and stencil mounting/tensioning, I have been able to achieve a positioning of the structural elements which perform these functions in a manner which enables each to perform its function in the required manner without the compromise inherent in the duality of function provided by the arrangement adopted in the elongated slot arrangement

of the above-discussed GB 460 and EP 902 specifications.

Thus, the stencil-fixing or mounting apertures are able simply to perform that function in a robust and practical way without the need to form part of a slender and therefore delicate stencil flexibility portion.

Likewise, the pattern of stress-relief apertures formed in the stencil are able to perform that function without any compromise as to their function, and this separated functionality represents a significant advantage.

In short, we have devised a stencil construction which not only meets the need for a stencil able to cooperate with the existing stencil-mounting and stencil-tensioning frame but which is able to offer significant technical improvements over the previously available stencils.

In the embodiments of the invention there is provided, in at least some of these, the feature that the zone or region within which the fixing holes are located at the two opposite edges of the stencil, or indeed in the four opposite edges thereof are actually physically separated from the corresponding regions of stress relief. Such separation is effective to ensure that the distinct functions of these portions of the stencil are visibly and functionally separated. Indeed, there is no functional requirement for any relationship between the stencil mounting function and the stress relief or flexibility function since the former serves merely to provide a means whereby the stencil may be anchored to the means whereby it is tensioned, regardless of the mechanical details or complexity of the latter.

The physical separation of the stress relief or flexibility zone and the mounting holes zone has functional significance in the following respect, namely that the stress relief band or zone should preferably be positioned so that, approximately, the mid point of its width (measured in the direction of the width or length of the

stencil in a straight line direction at right angles to the stress relief zones at the edges and between same) is approximately at the location on the stencil where its maximum change of profile occurs. The change of profile is between the generally flat region (at the top of the stencil/frame assembly) where the stencil pattern (eg for solder paste stencilling) is located. And the two opposite end regions of the stencil where it bends downwards towards its fixing means, so that the later do not get in the way of the stencilling operation.

In some stencil frames the change in profile of the stencil is achieved by means of a convex linear edge region of the stencil (at two or four opposite edges thereof) and in some other stencil frames the change in profile is achieved by means of one or two pairs of longitudinal angularly-rotatable cam members at the opposite edges of the stencil, which can be raised to tension the stencil and to provide the necessary change in profile.

Thus, the zone or region of stress relief or flexibility is preferably provided at a location which is nicely centrally disposed with respect to this region of stencil profile change.

More specifically, the zone of flexibility or stress relief is most needed at the location where the stencil first becomes flat after its profile change. This is the location where there is a tendency for the stencil to (by virtue of its inherent stiffness arising from its metallic sheet format) continue to adopt the upwardly (when the frame is in its usual horizontal altitude) inclined disposition, at least for some appreciable short distance from the edge of the stencil, so that there is a region of the stencil in which it is slightly lifted from the intended planar format in this top region of the stencil (which is its underside during actual stencilling) accordingly. Such is obviously undesirable and the zone of

stress relief and flexibility serves to minimise or avoid this affect by allowing the stencil immediately to adopt at the required location the change in profile from its upward inclination (or downward when in use) to its horizontal planar profile. In the corner regions of the stencil there is a three-dimensional effect in the case of stencils used with tensioning at all four edges of the stencil. In the case where tensioning is only applied at two edges, this effect does not arise. However, in the case of a stencil frame providing tensioning at all four edges of the stencil it will be readily understood that the stencil is actually being caused to adopt a three-dimensional format in which there is a flat top (for the actual stencilling operation) with a four-sided somewhat quadrihedral format with some degree (depending on the stencil frame profile) of convex format in the upwardly-tapering edge regions. Accordingly, the four corner regions of the stencil need to accommodate this format and are, in the embodiments, provided with (as seen in the flat format of the stencil) trimmed or otherwise removed corner regions so that the longitudinally-extending edge regions of the stencil can, when mounted on the frame, approach each other at their adjacent ends without redundant stencil material interfering. In these four regions, the fixing holes in the stencils are not provided and the region or band of flexibility or stress relief is extended into the corner regions so as to facilitate the adoption of the three dimensional profile. Such extension of the zone of flexibility may extend up to the trimmed or profiled formed edge of the stencil which lies beyond the lateral extent of the two adjacent (at right angles) lines or regions of fixing holes in the stencil.

As to the stencil fixing holes themselves, the size and spacing of these is adopted solely to accommodate the requirements imposed by the fixing elements of the stencil

frame in question. Thus, in the case where the stencil frame is provided with rows of stencil-fixing or mounting elements in closely-spaced format with provision to accommodate the tensioning movement of the frame mounting elements, the lengthwise dimension of the mounting holes is somewhat greater than is required in the case where the mounting elements are fixed and the stencil is merely lodged over them and other means is provided for tensioning of the stencil. Thus, where the stencil mounting and tensioning elements move relative to the stencil, the mounting or fixing holes are proportioned to accommodate such movement. In the case of frames where this movement is controlled by a system of pneumatic actuators in which pneumatic pressure is applied to release the tensioning members or hooks against the action of spring forces acting in the tensioning direction, there is a need to accommodate the limit of movement of the tensioning or fixing members in the stencil-releasing direction in the case where the user applies excessive pneumatic pressure in the stencil-releasing direction. This leads to a need for the fixing holes to be somewhat more elongated than would otherwise be the case, but the lengthwise dimension is not particularly great and the technical effect is solely to accommodate such movement of the fixing members.

In a further embodiment the stencil is intended for use in relation to a stencil mounting and tensioning frame in which the edge portions of the stencil are unsupported in the edge region between their engagement with the spring-actuated multiple-tensioning elements or fixing members, and the region of the stencil frame (spaced therefrom) which is in the form of a planar rectangle defining the stencilling zone), where the stencil changes is profile in use from the inclined sides of a flat-topped pyramid, to the flat top thereof.

In the embodiments of EP902B and GB460B

(Williams/Alpha) discussed above, the elongated slots which serve as both the means for mounting and fixing the stencil and for providing it with the necessary level of flexibility, extend lengthwise and inwardly of the stencil a sufficient distance that their inboard ends (which are laterally aligned) extend to a position which is approximately half way across the width of the rectangular structure defining the stencilling zone whereas in the embodiments of the invention the flexibility or stress relief zone which is spaced from the stencil fixing holes is of a width such as to fully encompass the structure of the planar frame edge defining the stencilling zone, thereby ensuring a more effective and complete provision of the flexibility function which is a key to the proper compliance of the stencil with its frame-imposed profile requirements in use.

An important aspect of the construction of the embodiments relates to the dimensional relationship between the fixing hole spacings and the stress relief formation spacings. We have discovered that in the case where these functions are provided by the discrete bands or stencil portions as disclosed in the present application then there is a significant benefit to be obtained by adopting a level of dimensional commonality as between these spacing dimensions in order to achieve a related balancing or evening-out of the lines of stress which are generated when stencils are tensioned and which otherwise interfere with the effective adoption of the required frame-imposed profile in use.

We have discovered that the stress relief formations, when disposed in a band of same, the band being formed by a pattern of apertures or openings or recesses formed in the stencil material, then the size and spacing of these should preferably be related to the corresponding size and spacing of the fixing holes so that the spacings between

the stress relief formations are not substantially different from those between the fixing holes. In this way the level and distribution of stress is obliged to adopt an equalised pattern in this critical area of the stencil.

Our measurements show that the spacing between the fixing holes (centre-to-centre) divided by the corresponding spacing between the stress relief formations should be in the range of 0.75/1 to 5/1 and preferably in the range of 1/1 to 2/1, the dimensions being measured in the same direction, that is to say, the linear dimensions measured between successive mounting or fixing holes are measured along a line parallel to the line along which the spacing of the stress relief apertures is likewise measured.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

Fig 1 shows a prior art construction, being a copy of Fig 1 of the drawings from the above-discussed GB2264460B specification;

Fig 2 shows, on a larger scale, a corner portion of a stencil, generally in accordance with the disclosure in the GB460B specification;

Fig 3 shows a photocopy of a stencil, likewise representing the prior art, illustrating an alternative manner of fixing a stencil to a corresponding mounting frame; and

Figs 4 and 5 show, in views somewhat corresponding to that of Fig 2, two alternative embodiments of the invention in each of which there is provided a row of mounting apertures and and associated array of stress relief openings.

Turning first to Fig 1, as mentioned above, this shows a stencil 10 as disclosed in the above-discussed GB460B specification comprising a rectangular sheet of flexible

metallic sheet adapted for electrolytic etching, and having mounting apertures 12 disposed in twin bands 14, 16, one at each of the longitudinally spaced ends 18, 20 so that the stencil can be tensioned in the longitudinal direction between these mounting apertures.

The mounting apertures 12 are linear in format and relatively narrow, and closely spaced. The length of the apertures 12 is such that they extend over the full length of that portion 22 of the stencil which needs to be flexible and/or to have stress relief in order that it can be tensioned while simultaneously adopting a non-flat format in order that the central region 24 can be in a flat and raised condition with respect to the edge portions 26, 28 for stencilling purposes.

In use, stencil 10 has a pattern of apertures (not shown) etched or otherwise formed in its central region 24 through which solder paste or the like is caused to pass by a squeegee or the like action, as described above.

Turning to the construction shown in Fig 2, this shows an adaptation of the stencil of Fig 1, in which arrays of the combined mounting and stress-relief apertures 12 of the construction of Fig 1 are provided in bands 30,32 extending along adjacent edges 34, 36, and likewise along the other two adjacent edges of the stencil 38, so that the latter can be tensioned outwardly in all four directions instead of in the two directions permitted by the stencil 10 of the construction shown in Fig 1.

In the construction of Fig 2, the apertures 40, corresponding to the apertures 12 in the Fig 1 construction, are somewhat wider in lateral width, and slightly less closely spaced than appears from the construction shown in Fig 1. Fig 2 is slightly large with respect to the actual size of the stencil, the centre-to-centre spacing of the apertures 40 being typically 3.0 mm in practice.

The longitudinal extent 42 of the apertures 40 is typically 19 mm, and such corresponds generally with the corresponding extent indicated in Fig 1, in that it is sufficient for the edge portions 44, 46 to be bent downwards away from the central region 48 of stencil 38, where the stencilling operation is performed, with the necessary flexibility so that the stencil can adopt its flat contour in the central region without the loss of an edge region in which there might otherwise be a raised portion in which the metallic sheet accommodated itself to the change in profile.

Although not shown herein, the construction and arrangement of the mounting members which are employed for entering the apertures 40 of the stencil 38 of Fig 2 is generally as disclosed in the GB460B discussed above, though these are arranged along all four sides of the rectangular tensioning frame, rather than just along two opposite end edges.

It will be noted that in the construction of Fig 2, the two linear edges 34, 36 of stencil 38, which are disposed at right angles, are joined by an equally mutually inclined corner edge 50, whereby the otherwise-present triangle of metallic stencil sheet material is removed and thus not required to conform to the somewhat pyramidal edge format which the stencil is forced to adopt in its in-use tensioned condition.

There is shown in Fig 2 at 52 the dotted line rectangular outer edge of the linear and planar rectangular frame 54, which defines (within its inner edge (not shown) the open space within which stencilling is performed.

Thus, it can now be seen from the construction shown in Fig 2 that the entire extent of the length 42 of the apertures 40 (which in practice is of the order of 19 millimetres) is available to render that portion of the stencil flexible for contour following and stress relief

purposes between the outer end edges 56 of the apertures 40 (against which end edges the actuated mounted elements (not shown) act), to the opposite end edges 58 which are located on frame 54.

It will be noted that, of course, the mounting elements (not shown) which tension the stencil are conveniently disposed in a linear array for entry into the apertures 40, and thus such tensioning is not provided along the extent of corner edge 50 of the stencil. Thus, the arrays 60, 62 of progressively shortening apertures at the ends of the bands 30, 32 of apertures are not for co-operation with mounting elements, but for decorative purposes.

In use, the stencils of Figs 1 and 2 are assembled in relation to their associated tensioning frames as disclosed in the GB2264460B specification. The mounting elements are carefully positioned so as to enter into the narrow slots for apertures 40, and the mounting elements are then caused (under spring control) to move to the outer ends of the apertures to tension the stencils. The mounting elements are actuated by multiple springs. In order to demount a stencil after it has been tensioned, there is provided a pneumatic system comprising multiple pneumatic actuators adapted to compress the resilient springs to move the mounting members inwards relative to the stencil, to release same.

We have found that, even with the aperture format disclosed in the Fig 2 construction, though the effect is significantly stronger in the Fig 1 construction, there can be difficulties in mounting the stencil on its mounting frame in terms of ensuring proper engagement between the stencil and its multiple mounting members, so that each mounting member enters its appropriate slot or aperture.

The substantial length of the apertures does not, we find, ease this problem. Indeed, on the contrary, the

substantial length of the slots tends to exacerbate the problem in terms of making the edge portion of the stencil somewhat over-flexible, and inclined to interfere with the easy alignment of the stencil with its mounting members, with the resultant possibility (which occurs not infrequently in practice) of damage occurring as between the stencil and its strongly spring-actuated mounting members.

Before moving to the embodiments of the invention shown in Figs 4 and 5, we describe first the prior-used stencil of the present applicants as shown in Fig 3, in which there is shown a stencil 70 of metallic foil sheet material similar to that of the constructions used in Figs 1 and 2, having edge regions 72, 74 for co-operation with a mounting and positioning system (not shown) in which mounting pegs enter pear-shaped openings 76 and positioning pegs enter circular openings 78. The edge regions 72, 74 are clamped to a mounting frame (not shown) and the inner rectangular region 80 is raised with respect thereto (or lowered) by means of linear actuatable cams extending lengthwise of the edge region 72, 74 and actuated by means of end levers located in the corner region 82, generally in accordance with matters disclosed in GB2286156B and WO94/07696 (our reference P51953GB and WO).

Positioned inwardly of the edge regions 72, 74 of stencil 70 and extending lengthwise parallel to said edges on the inboard side of the openings 76 and 78 are a pair of stencil-stress relief regions 84, 86 which extend lengthwise the full length of all four sides of the stencil up to the three other corner regions corresponding to corner region 82. Each stress relief region or band 84, 86 comprises an array of openings or recesses disposed in a regular pattern, such openings or recesses being closely spaced and serving to produce enhanced flexibility in these regions of the stencil for permitting corresponding

flexibility of the stencil. In use, the stencil 70 is caused to change from an upwardly sloping profile to a flat profile at the locations indicated by dotted lines 88, 90 in Fig 3, which represent the approximate locations of the angularly-movable cams (not shown) which are used in relation to stencils 70 to effect the required tensioning.

It can thus be readily seen that in the stencil construction of Fig 3, there is a clear separation of function as between the edge regions 72, 74 and the stress-relief regions 84, 86, the edge regions serving to mount (by virtue of the openings 76, 78) the stencil on its mounting frame, and thus to hold the stencil in its tensioned condition, and the stress relief regions 84, 86 permitting the stencil to adopt its flat-topped profile for stencilling purposes.

Turning now to the embodiments of Figs 4 and 5, these will be described by reference to the above-discussed prior art constructions, for ease of description and understanding.

Thus, in the embodiment of Fig 4, stencil 100 comprises edge regions 102, 104 in which are provided arrays 106, 108 of mounting apertures or fixing holes 110 for co-operation with mounting elements (not shown) of the kind discussed above in relation to Figs 1 and 2. The mounting elements thus move in use between outward (spring-urged) stencil-tensioning positions and inward (pneumatic-actuator released) positions within the lengthwise extent 112 of apertures 110). The actual lengthwise extent of apertures is typically about 7 mm, being just sufficient to take in the full range of movement of the mounting elements, including that which can occur under abnormally high release pressure application. It will be noted that the dimensions of the fixing or mounting apertures 110 is similar to that of the pear-shaped openings 76 in the construction of Fig 3.

In order to accommodate the profile change requirements of stencil 100, the latter is provided with a band or region of stress relief apertures or recesses 114, 116 extending lengthwise parallel to the arrays 106, 108 of mounting or fixing holes along the adjacent edges of the stencil 100. It will be understood that this arrangement is provided lengthwise of all four edges of the stencil. Crosscut corner profiles 118 are provided somewhat as in the prior art stencils.

However, it is particularly to be noted that in the Fig 4 embodiment of the invention, the fixing or mounting apertures 110 are provided only where required for fixing or mounting purposes, and thus the arrays 106, 108 of fixing holes terminate at the crosscut corner profile 118, and the stress relief bands continue up to that corner profile and indeed extend around the ends of the arrays 106, 108 in stress-relief end enlargement regions 120, 122, these end enlargement regions almost meeting at the central corner point 124, so that the corner region generally 126 of stencil 100 (and likewise of course the other three corner regions) has a substantial provision of the stress-relief formations so as to well-accommodate the change in profile inherent in the matching of the stencil to its frame requirements, which correspond to those of the construction shown in Fig 2. There is shown in Fig 4 by means of the dotted lines 128 the outer edges of the rectangular frame over which the stencil is fitted and on which it forced to adopt the required profile.

It will be noted that the edge 128 lies well within the bands 114, 116 of stress relief, so that this profile change is easily accommodated.

Turning now to the dimensional aspects of the embodiment of Fig 4, we have discovered that there is a significant benefit to be obtained by adopting a level of dimensional commonality as between the spacing of the

stress relief apertures or depressions 130, and the corresponding spacing of the fixing holes or apertures 110.

In this embodiment, the centre-to-centre spacing of the stencil-mounting or fixing holes 110 divided by the corresponding spacing of the stress relief apertures 130 is 3.00 mm/2.54 mm (= 1.18/1), the dimensions being measured in parallel directions. The spacing between successive mounting apertures 110 is identified at 132 in Fig 4 and the spacing of successive stress relief apertures or recesses is identified at 134. The latter are spaced apart in linear rows 136. The mounting apertures 110 are likewise disposed in a row or array parallel to the rows 136.

It will be noted that the rows 136 of stress relief apertures or recesses are arranged in successively staggered relationship (as between the apertures) so that the closest spacing between apertures (measured between rows 136) is 1.27 mm as identified at 138. The same spacing applies to the inter-row separation of successive linear rows 136, as likewise shown at 138. This separation is not parallel to the separation of the fixing holes 110).

The fixing holes or mounting apertures 110 in Fig 4 are also shown in Fig 4 in enlarged format in which can be clearly seen the lengthwise extent 112, and the generally linear side edges 140, 142, which converge towards the outer end 144 by the angular dimension indicated at 146 of 2.053° at each side, whereby the outer end 144 has a shorter dimension than the inner end 148, whereby the mounting members (not shown) which tension the stencil are a close fit within the narrower outer end 144 and thus exert an alignment effect as well as a tensioning effect. The wider dimension of the apertures at their inner end 148 enables relatively easy entry of the mounting members therein, whereby the uncertainties arising from the relatively flimsy nature of the constructions shown in Figs 1 and 2 and the consequential not infrequent mounting difficulties

are avoided.

It is particularly to be noted that in the embodiment of Fig 4 there is provided a stencil separation band 150 between the stress relief band 114 and the array of fixing or mounting apertures 110. In the embodiment of Fig 5, this stencil separation band is dispensed with.

Thus, turning to the embodiment of Fig 5, it will be seen that the construction is otherwise exactly as disclosed above in relation to Fig 4, but the stencil separation band 150 is removed by widening the stencil stress relief bands 152, 154 (corresponding to bands 114, 116) so as to bring the stress relief apertures 130 close up against the mounting apertures or fixing holes 110. Otherwise, this embodiment corresponds exactly to that of Fig 4.

The significance of the stencil separation band 150 in Fig 4, and its absence in Fig 5, relates more to an understanding of the separate functions of the fixing holes and the stress relief holes than to a technically significant difference between these two embodiments. In fact, the provision of stress relief apertures or recesses in the stencil separation band 150 of Fig 4 has no particularly significant technical advantages and is to be adopted only if production or other factors favour it.

The dimensional commonality feature discussed above in relation to the separation of the fixing holes or mounting apertures 110 and the stress relief apertures or recesses 130 arises, we believe, from the mode of operation of the embodiments. There appears to be an advantage in providing a stencil tension-transmission path between the fixing holes and the main central region of the stencil, which leads to a more uniform stress transmission functional characteristic, where the dimensions have a reasonable level of commonality in accordance with the dimensions quoted herein, and our tests indicate that

departing significantly from these leads to a less satisfactory tension transmission path and a less satisfactory profile-following performance in use.

In the embodiments of Figs 4 and 5, a stencil 100 is adapted to be mounted on a tensioning frame as described previously in relation to the constructions of Figs 1 and 2, in which the frame comprises a plurality of mounting members to co-operate with the mounting apertures formed in the stencils. Moreover, the frame means is adapted to cause the mounting members to enter the mounting or fixing apertures of the stencils to effect relative movement between the mounting members and stencils to cause tensioning of the stencils.

CLAIMS

1. A stencil adapted to be mounted on a tensioning frame of the kind comprising:

Frame means adapted to mount a stencil thereon in a tensioned condition;

said frame means comprising a plurality of mounting members at opposite sides thereof and adapted to co-operate with corresponding pluralities of similarly spaced mounting apertures formed in said stencil at opposite sides thereof; and

said frame means being adapted to cause said mounting members to enter said apertures and to effect relative movement between said mounting members and said stencil to cause tensioning of the latter;

said stencil being formed with said mounting apertures to co-operate with said mounting members;

characterised by

said mounting apertures having generally linear side edges and being wider at their inner ends than at their outer ends (with respect to a central region of said stencil), and said apertures being adapted to enable said mounting members readily to enter said apertures in said wider portions thereof, and to cause same to exert a simultaneous stencil alignment and stencil tensioning effect as said mounting members move towards said outer ends of said apertures;

said stencil comprising stress relief means disposed in a band or region located at the inboard side of said mounting apertures so as to be located, in use, in the region of the stencil at which the profile of the stencil changes to follow a generally flat profile in said central region at which a stencilling operation is performed in relation to a pattern of apertures or openings formed or to be formed therein; and

said stress relief means comprising a pattern of openings or apertures disposed at mutual spacings such that the average spacing, centre-to-centre, of said stencil mounting apertures divided by the corresponding spacing measured in the same direction between the stress-relief apertures or recesses lies in the range of from 0.75/1 to 5/1.

2. A stencil adapted for use in relation to a stencil tensioning frame in which mounting members move outwards relative to the frame to effect tensioning of the stencil, characterised by said stencil comprising outwardly tapering generally straight-sided mounting apertures adapted to enable said mounting members to exert a progressive alignment effect on said stencil during tensioning.

3. A stencil according to claim 1 or claim 2 characterised by said stencil comprising said mounting apertures along all four sides thereof and having at least part of the corner regions of the otherwise rectangular stencil removed, said mounting apertures being disposed in rows extending towards said corner regions, and said stress relief means extending beyond the ends of said rows of mounting apertures into said corner regions of the stencil.

4. A stencil according to any one of the preceding claims characterised by said centre-to-centre spacings of said mounting and stress relief apertures lying in the range of 1/1 to 2/1.

4. A stencil adapted to be mounted on a tensioning frame substantially as described herein with reference to Fig 4 or Fig 5 of the accompanying drawings.

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Claims searched: 1-4

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Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): B6C (CEAS, CKW)

Int Cl (Ed.7): B41F 15/36; B41N 1/24; H05K 3/12

Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2286155 A (Cane)	
A	GB 2276589 A (Williams)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.